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ABSTRACT

This paper suggests four sources of inconclusive results in studies of school effects: Poor definitions of school context, poor sampling techniques, lack of attention to techniques of partitioning variance, and a lack of awareness of the effects of changing units of analysis on the size of statistical associations. Each problem is briefly described, and strategies for surmounting it are outlined. (Author)

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A METHODOLOGICAL NOTE ON CONTEXTUAL EFFECTS STUDIES IN EDUCATION

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A Methodological Note on Contextual Effects Studies in Education

Abstract

This paper suggests four sources of inconclusive results in studies of school effects: Poor definitions of school context, poor sampling techniques, lack of attention to techniques of partitioning variance, and lack of awareness of the effects of changing units of analysis on the size of statistical associations. Each problem is briefly described, and strategies for surmounting it are outlined.

A Methodological Note on Contextual Effects Studies in Education

For some time, the impact of schools on students has been the subject of intensive investigation by sociologists, and more recently, by economists. To date, the results of this research have been ambiguous. A quick overview of several studies (Boyle, 1966a; Coleman, 1961; Coleman et al. 1966; Krauss, 1964, Turner, 1964; Wilson, 1959, Bowles and Levin, 1968a, 1968b, Cambell and Alexander, 1965; Duncan, Haller and Portes, 1968; Hauser, 1969, 1970a, 1970b; McDill, Rigsby, Meyers, 1969; McDill, Meyers, Rigsby, 1967; Swell and Armer, 1966a; Mood, 1970; Kiesling, 1967; Nichols, 1964; Astin, 1963; Meyer, 1970; Boyle, 1966a) indicates that there are fairly wide ranges of opinion about the importance of school effects on students. In some cases, there has been a fairly extensive debate over the size and importance of school effects (see, for example, Bowles and Levin 1968a, 1966b) vs. Coleman, (1968), and Smith (1968). This debate was also joined by Cain and Watts (1968). One might also look at Hauser (1970a, 1970b) vs. Barton (1970), or Swell and Armer (1966a, 1966b) vs. Turner (1966), Michael (1966), and Boyle (1966b).

The very fact that a controversy exists is a striking finding. In an enterprise as expensive as the public school system, with educational inequalities of a fairly extensive nature, it ought to be possible to show consistent returns to different types of educational practices. The purpose of this paper is to discuss the inability of sociologists to show such returns, and to suggest some research strategies which might help to clarify the problem. The paper deals with four problems which are important in the study of school effects: the definition of school context, the sample of schools selected for a study, partitioning of variance in outcome measures, and the unit of analysis selected for study.

I. Definition of the Context

The contextual hypothesis examined by sociologists is that there are differences between schools which have an impact on educational outcomes for individuals. The impact of these differences will be over and above any impact attributable to individual characteristics of the pupils.

An example of this model (following Rogoff, 1961), is as follows:

(a) Ecological processes result in the segregation of socioeconomic groups within a community.

(b) The resulting segregation has the effect of segregating schools along socioeconomic lines.

(c) Attitudes and values, and specifically educational attitudes and values, vary among social classes.

(d) Thus, schools and neighborhoods will vary in modal aspirational levels and normative social climates.

(e) Schools (and school attendance areas) represent functioning sub-communities for students, and the characteristic attitudes and values of communities influence all of their members.

(f) Thus, modal aspirational levels and normative social climates of schools and their attendance areas affect all pupils, over and above the effects of students' own abilities, socioeconomic levels, aspirations, etc. For example, the aspirations of lower-class children in a predominantly middle class school will be higher than those of similar children attending predominantly lower-class schools.

There is a major flaw in describing school characteristics as aggregates of individual characteristics, especially as aggregates of individual social class. Aggregates such as socio-economic status, are proxy variables standing for events which are supposed to impinge on the lives of people (do the parents read to their children?). In order to understand what brings about an association (for

example) between socio-economic status and some output such as reading ability, one must resort to the variables for which SES is a proxy. This can be done inferentially with some degree of confidence for individuals, but the degree of inference required to make generalizations about school averages is large. Perhaps because of this many studies have found small associations between average contexts and some form of individual outcome.

An alternative contextual hypothesis commonly found in studies which attempt to discover effective resource allocation, is that better teachers produce better students. Since better teachers are paid more than poor teachers, there ought to be a positive association between teacher salary and pupil achievement over and above influences of individual characteristics of the pupils.

Again, a tremendous degree of inference is operating in the model. Teachers are usually paid according to their level education and their experience. There is no reason to assume that either of these variables is associated with good teaching.

If contextual effects studies are to produce useful results, a more detailed analysis of the educational inputs is needed. The futility of present studies is made apparent by imagining that a significant and indisputably large association was found between (for example) the average social class of a schools' students and pupil achievement. Aside from labelling the situation, what does this finding tell the school administrator. Given the political realities of public education--which make it difficult to take advantage of findings showing that it is undesireable to segregate students along racial or class lines--administrators need more detailed information about the causal mechanisms underlying these finding so that they can formulate appropriate policies for their own schools.

How might one go about providing more useful data to both the practitioner and the theorist? One way, would be to examine variables which differ from school to school, which are organizational properties of the school, and which

have some theoretical relevance to the outcome in which the researcher is interested.

For example, if one were to find the contextual relationship outlined above, would it not seem reasonable to look for organizational characteristics which differed from low SES to high SES schools? These might provide some useful insight into the causes of the observed phenomenom. If teacher salaries were associated with pupil achievement, would it not be reasonable to try and discover what high paid teachers did that low paid teachers did not do? Perhaps then it would be possible to provide data of theoretical and practical significance.

In sum, definitions of school contexts bases on macro or aggregate data will probably not provide useful information on the causal mechanisms by which school effects act. Variables which are more closely tied to the operation of schools are necessary.

II. The Cross-Sectional Sample of Schools

Even with an adequate definition of school context, it is difficult to be certain that pupils in a study have been under the influence of a given school effect for a meaningful length of time. Mobility of pupils from one school to another is a large contributor to this problem but an even more serious source is that students may move from one organizational context to another as they change grades (or for that matter, classes).

Further, the impact of school structure is apt to be cummulative, and to be more important during some parts of the school career than others (see Wilson, 1967: 171-174, 179, 190, for example). For this reason, cross-sectional studies should probably be used only to generate useful conceptions of school structure. Longitudinal studies with continual assessment of the sample schools's organizational structure, could then be used to generate the data for a good test of a contextual effects hypothesis.

III. Partitioning of Variance

The major analytical tool used by students of contextual effects has been ordinary least-squares regression analysis. The model is usually of the general form:

$$OUT_{ij} = f(CON_j + IBV_i) \qquad (2.1)$$

Where OUT is an educational outcome for individual i in school j

CON is a measure of context for school j

IBV is a set of background variables (such as sex, IQ) for individual i.

Analysts search for the association between educational outcomes and school contexts, holding constant the effects of background variables. In practice, this involves a comparison between (2.1) and a second regression model:

$$CON_{ij} = f(IBV_i) \qquad (2.2)$$

Differences in the predictive efficiency of (2.1) and (2.2) are attributable to school contexts. Frequently these are small, and researchers often conclude that school effects are insignificant.

One could be more confident of this result were researchers to (a) apportion variance between the School Context and BackgroundVariables and (b) report the maximum amount of variance in the Outcome which could be attributed to <u>any</u> differences between schools in the first place. These differences, it should be noted, not only include such "sociological" things as socio-economic and racial composition of the school, they also include "educational" things such as curriculum and teaching strategies.

Taking the second point first, the appropriate regression model is of the form:

$$OUT_{ij} = f(S_1 + S_2 \ldots + S_j) \qquad (2.3)$$

Where OUT is an educational outcome for individual i in school j

S_j is one if person i is in school j, zero otherwise

In short, the model is an attempt to predict an outcome solely from knowledge of the school in which the student is located.[1]

This model is of crucial importance, since it yields the upper limit of the amount of variance in the outcome which can be explained by any sort of variance in school contexts in the sample of schools.

Having computed equation (2.3), a researcher knows how much variance in an outcome could be attributed to differences between schools. Assuming that this is large enough to be of interest, he then wishes to know how much of that variance can be attributed to his measure of the school context.

This estimate is obtained by replacing the 1's in model (2.3) with estimates of the school context. Then, by collecting terms one arrives at a regression model:

$$OUT_{ij} = f(CON_j) \qquad (2.4)$$

Where OUT_{ij} is an educational outcome for individual i in school j

CON_j the measure of school context for school j

This model yields the amount of variance in the outcome which can be accounted for by differences in school context, neglecting the possible influence of controls.

The advantage of these procedures is readily shown by an example. Using data from a study of Bureaucracy and Alienation, measures of Alienation from School (OUT), School Bureaucratization (CON), and students' socio-economic background (IBV) were computed.

[1]This regression model uses a series of "dummy variables" to predict the outcome. Any other analysis of variance technique which revealed the amount of variance between schools would be appropriate.

Means, standard deviations and intercorrelations were then calculated for these variables (and for others to be used later in this paper).[1] The results are shown in Table I.

INSERT TABLE I HERE

The four regression models outlined above were then computed from the data in Table I. The results of this analysis are shown in Table II.

INSERT TABLE II HERE

Data continued in Table II heads off a number of issues which are often debated in the contextual effects literature. First, an examination of column 2.3 shows that only 6.4% of the variance in Alienation from School is attributable to differences between schools. Since this is the upper limit on the amount of variance which can be explained by differences between schools, we are spared a

[1]The data were collected from a random sample of schools located in Ontario, Canada. The sample was stratified on the basis of school district size, school type and location (rural or urban). One thousand, eight hundren and ninety grade 10 students provided acceptable data dealing with their perceptions of school bureaucratization, feelings of alienation from school, and their parents' occupations. A second set of 1,890 students were used as a basis for computing aggregate Bureaucracy and Alienation scores for each school. The bureaucracy scale reported here measures attempts by school authorities to control the behavior of students and is derived by extensive modification of Hall's (1961) measure of bureaucratization. The alienation measure is a composite of Seeman's (1959) five dimensions of alienation. The measure of social class is an adaptation of the Blishen Scale, (Blishen, 1965) a socio-economic status index developed for use in Canada. More complete descriptions of the development of the alienation and bureaucracy scales may be found in Anderson (1970).

debate over the causes of a small amount of variance being explained by the predictors. The explanation is simply that there are few differences in alienation attributable to differences between the schools in the sample.

The state of affairs revealed by 2.3 is undesireable from the viewpoint of the contextual effects researcher, but it may well be quite common in education. It is most probable that there is much more variation between children than between schools on most educational outputs, so one would expect a relatively small amount of the total variance to be explained by differences between schools.

Model 2.4 (Table II) shows the effect of restricting differences between schools to differences in school bureaucratization. The difference between this model and model 2.3 reflects the fact that restricting differences between schools to differences in Bureaucratization reduces the variance of school context. In other words, it shows the extent to which this one contextual variable underspecifies the school context. Contextual effects researchers are prone to stumble on this point, since they seem oblivious to the relationship between 2.4 and 2.3.

Models 2.1, 2.2, and 2.4 can be used to obtain estimates of the independent effects of context and background variables on the outcome (Mood, 1971). From 2.1 we see that school bureaucratization (CON) and socio-economic status (IBV) account for 4.3% of the variance in alienation (OUT). The independent effect of bureaucratization is found by comparing 2.1 and 2.2, the difference between the two models (3.3%) is the independent effect of bureaucratization. The independent effect of socio-economic status (negligible) is found by comparing 2.1 and 2.4. Overlap between bureaucratization and social class (owing to the fact that the two are correlated) is found by adding 2.2 to 2.4 and subtracting the resulting total from 2.1. In this case, 1% of the variance in alienation from school is attributable to overlap (or multi-colinearity) between the two independent variables.

TABLE I

MEANS, STANDARD DEVIATIONS AND CORRELATIONS BETWEEN ALL VARIABLES

Variable	Symbol	OUT	GOUT	IBV	GBV	IPCON	CON
Alienation from School (individual level)	OUT	1.00					
Alienation from School (school means)	GOUT	.25	1.00			N = 1,890	
Socio-economic Status (individual level)	IBV	-.10	-.27	1.00			
Socio-economic Status (school averages)	GBV	-.15	-.61	.44	1.00		
School Bureaucratization (individual perceptions)	IPCON	.52	.24	-.18	-.27	1.00	
School Bureaucratization (school means)	CON	.21	.82	-.40	-.90	.29	1.00
Means		-.011	-.011	3.769	3.768	-.145	-.145
Standard Deviations		.999	.253	1.915	.839	.987	.291

TABLE II

REGRESSION EQUATIONS PREDICTING INDIVIDUAL ALIENATION

FROM SCHOOL CONTEXT AND SOCIAL CLASS

Predictors		Equations			
		2.1	2.2	2.3	2.4
CON		.677			.710
IBV		-.012	-.053		
School	1			-.795	
	2			-.579	
	3			-.260	
	4			-.495	
	5			-.305	
	6			-.195	
	7			-.628	
	8			.015	
	9			.159	
	10			.050	
	11			-.417	
	12			.000	
	13			-.224	
	14			-.249	
	15			.000	
	16			-.464	
	17			.134	
	18*			.000	
RSQ		.043	.010	.064	.043

Independent CON = ((2.1) - (2.2)) = 3.3% (p. = .0000)
Independent IBV = ((2.1) - (2.4)) = 0.0% (p. = .3176)

Overlap = ((2.4 + 2.2) - (2.1)) = 1%

*All 18 schools were included. This is possible because iterative regression techniques, described by Greenberger and Ward (1956) and Ward (1962), were used.

Careful partitioning of variance, as outlined above, does much to aid understanding of contextual effects, especially in cases where overlap is high. Ultimately, there is little that can be done about the problem of multicolinearity other than to seek situations in which it is possible to maximize variance in the school characteristic being studied while randomizing out some of the most troublesome interferring variables. An example might be drawn from studies which show a high overlap between the average salary of teachers and the average SES of students. If one wished to study the effect of teacher salary independent of student SES, one might seek situations where teacher salary varied independent of social class. High salaries might be found in both high SES neighborhoods and areas where there was a large amount of federal aid. Low salaries might be sought in wealthy areas as well as in poor neighborhoods. Such a sample might minimize the overlap between SES and teacher salary, and allow a researcher to study the independent effect of each more effectively than could be done in a random sample.

Before leaving the issue of partitioning variance, a word about control variables is in order. The typical contextual effects study controls for the quality of a student input to the system, and seeks school effects over and above these variables.

Since all students do not have the same characteristics, a more appropriate analysis procedure calls for separate analyses for different types of student wherever "type of student" is thought to be an important variable. Coleman for example, finds quite different regression equations for different ethnic groups when he attempts to predict verbal achievement from school and background variables (1966: 299-306). This fact could have been lost had Coleman merely controlled for ethnic origin.

IV. The Unit of Analysis

Tables I and II contain two units of analysis: individuals and groups. It has been known for some time that changing units of analysis alters the size of correlation coefficients and a good deal of work has been done in organizing the theoretical and methodological implications of this fact.[1] However, little seems to have been done to examine the effect of mixing units of analysis in the same study, yet this is by far the most common form of analysis used by students of contextual effects.

Basically, one finds two units of analysis in sociological research: the individual and some form of group. This leads to four pair-wise combinations of independent and dependent variables:[2]

	Dependent	Independent
(1)	Individual Outcomes	Individual Attributes
(2)	Group Outcomes	Individual Attributes
(3)	Individual Outcomes	Group Attributes
(4)	Group Outcomes	Group Attributes

Contextual effects studies are usually a combination of (1) and (3), that is, they use individual and group attributes to examine individual outcomes. To systematically explore grouping in these studies, four models may be investigated with the data described above:

$$3.1)\quad OUT_{ij} = f(IPCON_{ij} + IBV_{ij})$$

$$3.2)\quad OUT_{ij} = f(CON_{j} + IBV_{ij})$$

$$3.3)\quad OUT_{ij} = f(CON_{j} + GBV_{j})$$

[1]Hannan (1970) offers an excellent overview of this work.

[2]Riley (1964) expands this issue.

3.4) $GOUT_j = f(CON_j + GBV_j)$

Where OUT = an outcome for person i in school j

GOUT = average outcome for all students in school j

IPCON = individual i's perception of the context of school j

CON = a measure of the context of school j

IBV = a background variable for person i in school j

GBV = average background measure for all students in school j

Model 3.1 is rarely seen in contextual effects studies because the context is not normally assumed to have an "existence" at the individual level. Nonetheless, its inclusion proves illuminating in the study of aggregation. Model 3.2 is what might be called the traditional contextual effects model, while model 3.3 assumes two different measures of context, an organizational property and an aggregation of individual properties. Model 3.4 used if schools are the unit of analysis in a study.

The application of these models to the data are shown in Table III. As can be seen from the Table, there are very marked changss in the amount of variance

INSERT TABLE III HERE

explained by school context and social class as the units of analysis change. At individual levels (model 3.1a) school context explains 27.3% of the between - student variance in alienation. However, aggregating the school effect alone (model 3.2a) reduces this to only 4.3%.

Aggregating both the school context and the background variable by school (model 3.3a) increases the amount of between-student variance explained by the full model to 4.9%, but reduces the independent contribution of the original measure of school context. However in this model the aggregated background variables in another measure of context, and school differences of <u>any set</u> can explain no more than 6.4% of the variance in individual alienation. Aggregating

TABLE III

REGRESSION EQUATIONS PREDICTING INDIVIDUAL AND GROUP ALIENATION

FROM SCHOOL CONTEXT AND SOCIAL CLASS

Model Number	Predictors					
	Criterion	Context	Background	Constant	RSQ[1]	Contributions to Variance
3.1a	OUT	.528[2] IPCON	-.005 IBV	+.083	.273	Overlap = 1.0%
3.1b	OUT	.529[2] IPCON		+.066	.273	Independent IBV = 0.0%
3.1c	OUT		-.053 IBV	+.189	.010	Independent IPCON = 26.3%
3.2a	OUT	.677[2] CON	-.012 IBV	+.134	.043	Overlap = 1.0%
3.2b	OUT	.710[2] CON		+.092	.043	Independent IBV = 0.0%
3.2c	OUT		-.053 IBV	+.189	.010	Independent CON = 3.3%
3.3a	OUT	1.267[2] CON	+.213[2] GBV	-.639	.049	Overlap = 1.8%
3.3b	OUT	.710[2] CON		+.092	.043	Independent GBV = .6%
3.3c	OUT		-.184[2] GBV	+.681	.024	Independent CON = 2.5%
3.4a	GOUT	1.267[2] CON	+.214[2] GBV	-.634	.757	Overlap = 27.8%
3.4b	GOUT	.708[2] CON		+.092	.665	Independent GBV = 9.2%
3.4c	GOUT		-.183[2] GBV	+.679	.370	Independent CON = 38.7%

1. All RSQ's are significant ($p. \leq .01$).

2. Significant Beta weight ($p. \leq .01$).

both the dependent and independent variables (model 3.4a) raises the variance explained to a full 75.7%, but now the model explains between school variance. Thus, model 3.4 explains 75.7% of the 6.4% explained by model 2.3.

Which of these models are we to use in studying school effects? It could be argued that one should use the aggregate model, since it produces the "largest" effect. But at the very least, Robinson's (1950) paper should alert us to the possibility that such a large squared multiple correlation may be an overstatement of the association between school properties and individual results. On the other hand, use of the individual - individual model is complicated by three problems: the probability of response bias when an individual provides perceptual data on both sides of the regression equation, the likelihood that data obtained on the individual level are either not suitable or are unavailable for the analysis and, most important, the fact that individual - individual models do not reflect the theoretical model which deals with organizational impacts on individual outcomes. The latter point is important, for not only do the sizes of correlations change, in some studies their sign has changed when the units of analysis are altered.[1]

Looking over Table III one may note that, while the squared multiple correlation is undergoing very substantial changes, the unstandardized regression weights attached to each variable remain comparatively stable. Here we may see a key to the interpretation of contextual effects data.

The regression weight is the amount of change in the dependent varibble which may be expected to arise per unit change in the independent variable. Weights in equations involving more than one variable show the amount of change to be expected in the outcome per unit change in the independent variable in the presence of other factors in the equation. Considering the aggregation which has

[1]See Bonjean and Grimes, 1970: 368, for an example.

been performed in moving from 3.1 to 3.3 or 3.4, the regression weights have remained quite stable. They are simple to interpret, and have some practical meaning.

The regression equation, and not the amount of variance explained, seems to be the appropriate means of seeking the size of school effects. In fact, this is precisely what Blalock means when he notes that

> ...if there is any degree of assurance that in effect manipulations have been made primarily in terms of the independent variable, then comparisons involving slopes will ordinarily be more meaningful than those using correlation coefficients....Basically, our interest in correlation coefficients in these comparisons should be mainly to help us determine the degree of accuracy in our estimates of slopes. (Blalock, 1964: 126, emphasis added).

Given this interpretation, then, one would assume that the school effects found in these data were significant, but that they could not be expected to be the same for all individuals in each school. Such an interpretation seems much more reasonable than the dismissal of school effects entirely on the grounds that they explain a trivial amount of the variance in alienation. In fact, the amount of variance attributable to school effects is very dependent upon the units of analysis selected for a study, while the regression weights are apparently much more stable across levels of aggregation.

Implications

Three factors have been suggested for the inconclusive results of contextual effects studies: their reliance on theoretically and practically useless variables, their failure to study and partition variance, reliance upon squared multiple correlations from regression equations as measures of the importance of school effects.

To overcome these problems, three or four research strategies may be proposed. First, researchers ought to formulate their studies in terms of variables which have relevance in a causal sense (i.e., which are more than descriptive of the status quo). Second, samples ought to be chosen so as to maximize variance in the school context under study, while randomizing or better yet blocking on, variables which would tend to be correlated with the school context in a random sample. Further, longitudinal, as opposed to cross-sectional, studies are required. Third, the extent to which data allow statements about the independent effects of variables ought to be examined. This requires an attempt to determine the independent contribution of each variable to the variance explained. The more overlap between variables, the less able one is to specify the correct regression weights for any variable in the regression equation. The type of partitioning recommended by Mood (1971) is probably appropriate for this sort of analysis. Fourth, researchers ought to reduce their emphasis on the squared multiple correlation coefficient as the role estimate of the strength of the relationship between a criterion and a set of predictors. A better estimate of the importance of an independent variable is found by regression weights with the squared multiple correlation coefficient serving as an estimate of the accuracy of the model linking the independent variables to the criterion. Points three and four amount to a suggestion to use two of four research strategies proposed by Lina & Weit (1969). Researchers also need to make efforts to determine the maximum amount of variance which could be explained by differences between schools or classrooms. They could then estimate the effectiveness of their variables in representing those differences. Above all, researchers need to be careful to point out which sort of variance their statistical models explain. All too often, models explain variance or represent a theory which is different than that which the researcher wishes to study.

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